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## A TURRENT FOR GLASS-BENDING FURNACES

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A new design for a manipulator turrent intended for the fixation of large-size windshield glasses in bending is considered. The device allows for gripping a flat glass packet (glass + film + glass) before bending, as well as molded glass after bending, and placing it on a carrier car. The kinematic scheme and the layout of the device are presented.

At present large-size windshield glasses are manually loaded into furnaces for glass bending. Usually four people have to simultaneously grasp cautiously a glass sheet with fingers in such a way as to distribute the glass weight evenly between the four workers. After that, transporting and charging (discharging) operations are implemented.

Manual charging of furnaces has the following drawbacks: low efficiency, large sizes of the furnace container that holds the glass-shaping frame and, accordingly, increased dimensions of the furnace itself; reduced furnace efficiency due to heat losses; increased risk for workers, since occasionally heated glass breaks in their hands.

To avoid the above defects we have developed a special turrent for the fixation of large-sizes glass sheets in a packet (glass + film + glass), which is attached to a standard manipulator or an overhead-track hoist. The new technical solution (RF Inventor's Certificate No. 24993) allows for replacing the labor of four workers by just one.

Figure 1 shows the positions of the contact points of hooks 1 of the new turrent with respect to glass 2 bent in three mutually perpendicular planes. The scheme simulates the performance of four operators. In order to provide contact at eight points, each hook should rotate in two planes: angle  $\varphi_i$  in plane  $xOz$  and angle  $\alpha_i$  in plane  $xOy$ . There is no need for rotation in plane  $zOy$ , since the glass becomes self-positioned in this plane based on two points for any curvature.

It follows from Fig. 1 that the hooks rotate at points A, B, C, and D located in one plane ( $xOy$ ), which contradicts the theory of basing. Consequently, two out of four points ought to be self-aligning. Therefore, in order to ensure contact with the glass under any curvature, the new turrent should have nine degrees of mobility. According to the layout of the contact points, a kinematic scheme of the turrent having nine degrees of mobility was developed (Fig. 2). The hooks 1 are

linked via hinges with a Hooke's semispider 2, which is flexibly linked with a cross-piece 3. The cross-piece is flexibly linked with the case 4 at point E, which provides for self-aligning of points B and C with respect to the base plane AED that belongs to the case 4.

According to the considered kinematic scheme, we have developed and implemented a turrent for the fixation of glasses of length  $L$  ranging from 1200 to 2200 mm and width  $B$  from 1000 to 1800 mm, which ensures hooking both of flat glass before bending and curved glass after bending.

The layout of the turrent is indicated in Fig. 3. The case in this device is represented by a rectangular pipe 1 welded to the right cross-piece 2. Inside pipe 1 there is an inner rectangular pipe 3 linked via hinges with the left cross-piece 4. Inside the pipe 3 there is a nut 5 linked by thread with the lead screw 6. The screw rotates with respect to the right cross-piece and forms a hinge-immobile support. To the right of the lead screw there is a handle 7. Four Hooke's semi-spiders 8 are fixes by hinges to the left and right cross-pieces, which, in turn, are connected by hinges to the hooks 9. A plate 10 is welded to the case 1 and contains holes made in

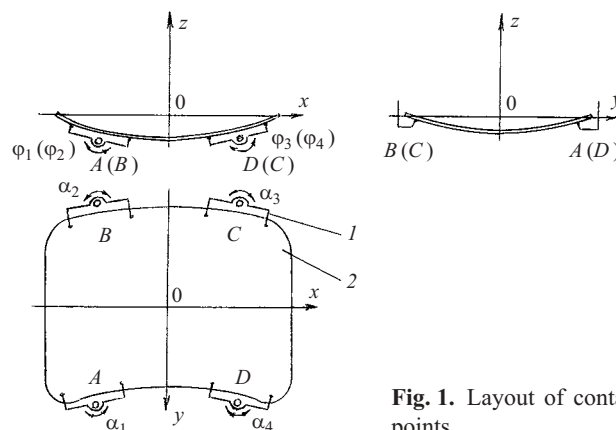


Fig. 1. Layout of contact points.

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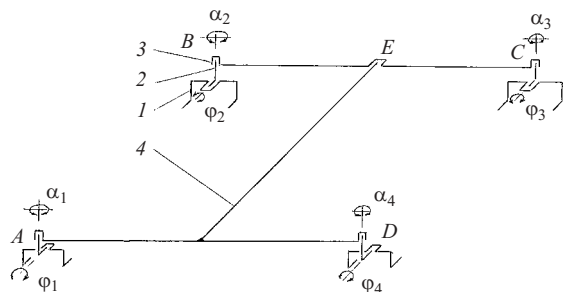


Fig. 2. Kinematic scheme.

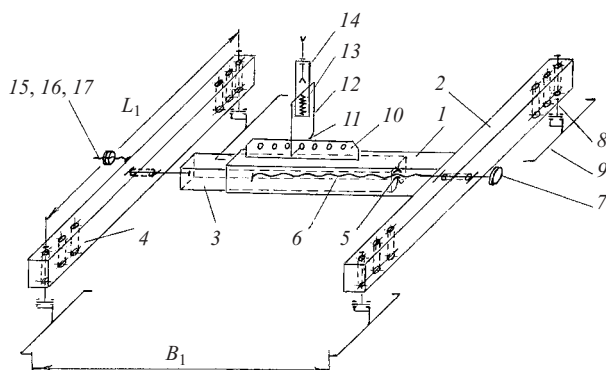


Fig. 3. Layout of the turrent.

order to transport the axis 11 to the gravity center of the turrent. The shaft is fixed in the reversing gear 12 relying on a shock absorber 13 linked with the casing 14.

Before the turrent is used, it has to be adjusted to a preset glass size  $B \times L$ , for which purpose the turrent is suspended on a manipulator or an overhead-track hoist using the casing block 14.

Adjustment of the turrent is implemented along the glass sheet length by shifting the position of Hooke's semispiders 8 in the vertical holes of the left and right cross-pieces in such a way as to uniformly distribute the glass gravity among all points of contact with the hooks 9. Adjustment of the turrent with respect to glass width  $B$  is implemented by varying the distance  $B_1$  between the hooks on the left and right

crosspieces, which is performed by rotating the handle 7. As the handle rotates, the screw-nut transmission transforms the rotary motion of screw 6 into translational motion of the inner pipe 3 with respect to the case, whereas the distance  $B_1$  changes. The size  $B_1$  is adjusted to exceed by 4–8 mm the glass width  $B$ .

Since in changing of the width  $B_1$  the gravity center of the turrent is shifted along the rectangular pipe 1 and the turrent deviates from the horizontal position, the shaft 11 has to be transferred to a respective opening in the plate 10 located as near as possible to the gravity center. In order to return the turrent to the horizontal position, there is a screw 15 with a balance nut 16 and a checknut 17. By rotating the balance nut the turrent is brought into a horizontal position and the balance nut is fixed with the checknut. This is the end of adjustment.

After that, the turrent operates in accordance with the glass bending technology. By means of the manipulator the turrent is brought from the initial position to the mount table, on which the flat glass is placed. The lifting mechanism lowers the turrent in such a way that the hooks 9 are below the glass level. By turning the handle 7, the distance  $B_1$  is changed in such a way as to make it smaller than the glass width  $B$ . Next, the manipulator raises the glass and transports it into the bending furnace container onto the shaping frame. By turning the handle, the hooks are moved beyond the glass sheet limits and the manipulator takes the turrent out of the bending furnace into the initial position.

After the end of the bending process, the turrent fixes the curved glass and moves it to a carrier car. The operator rotates case 1 clockwise to shaft 11 through an angle of  $70 - 80^\circ$  and using the manipulator places the glass piece onto the car. Having freed the turrent from glass, the operator returns the turrent into the initial position.

The performance of the new turrent for a year has demonstrated its reliability. There have been no instances of glass fractures related to the turrent operation.

The use of the new turrent made it possible to mechanize the loading and discharge of furnaces for bending large-size glass sheets and significantly improve the efficiency and safety of the process.